WE [redacted] M:

1. In a method of operating a hemodialysis machine, an improvement in a man/machine interfacing process used in changing a treatment parameter, the improvement comprising:

providing a touch screen interface with an indicia thereon corresponding to a treatment parameter;

touching the indicia;

in response to said touching, invoking a new keypad display on a region of the touch screen;

entering a numeric parameter corresponding to the treatment parameter by touching one or more buttons of the displayed keypad;

touching a first region of the keypad to signal end of entry of the numeric parameter;

displaying on the touch screen a button soliciting verification of the newly entered numeric parameter;

touching the button soliciting verification; and

in response to said actions, causing the treatment parameter to be changed;

wherein erroneous changes of treatment parameters are minimized.

2. The method of claim 1 which further includes removing the button soliciting verification from the screen if it is not touched within a predetermined period, said predetermined period being less than fifteen seconds.

3. The method of claim 1 which further includes:

establishing upper and lower limits for the parameter; and

displaying said limits on the screen when the keypad display is invoked to change the parameter, said limits being displayed at the location on the screen where the indicia corresponding to said parameter was displayed prior to the touching of said indicia.

4. A method of programming a time varying parameter in a process control system, the method comprising the steps:

providing a touch screen interface;

displaying on the touch screen first and second axes, the first axis corresponding to the time varying parameter, the second axis corresponding to time;

touching the touch screen at a plurality of points to define points on a parameter versus time curve;

presenting on the touch screen a series of bars corresponding to said curve;

selecting one of said bars for alteration;

displaying a numeric parameter corresponding to the selected bar on the screen;

touching the screen at first or second locations to increase or decrease, respectively, the displayed numeric parameter and thereby alter the value of the parameter to which the selected bar corresponds;

touching the screen at a third location to signify completion of the programming; and

storing data corresponding to the bars in a memory to which the process control system can refer in changing the parameter with time.

5. The method of claim 4 which further includes:

presenting on the screen a first series of bars corresponding to historical values of the parameter, said first series of bars being displayed with a first visually perceptible character;

displaying on the screen a second series of bars corresponding to upcoming programmed values of the parameter, said second series of bars being displayed with a second visually perceptible character different than the first; and

permitting only bars of the second series to be selected for alteration.

6. The method of claim 5 in which the process control system is a dialysis machine.

7. The method of claim 6 in which the time varying parameter is ultrafiltration, and in which the method further includes displaying on the screen a numeric parameter corresponding to an area under the parameter versus time curve, said area representing the total ultrafiltrate programmed to be removed from a patient.

8. A method of operating a dialysis machine to establish desired treatment parameters, the method comprising the steps:

providing first and second data card interface devices, the first device being associated with a computer, the second device being associated with the dialysis machine;

operating the computer in conjunction with the first data card interface device to load into a data card a set of desired treatment parameters, said set including parameters relating to three or more of the following:

ultrafiltration profile;
sodium profile;
bicarbonate profile;
blood pump flow rate;
treatment time;
dialysate flow rate;
dialysate temperature;
blood pressure measurement schedule;
blood pressure alarm limits; and
heparin prescription

operating the dialysis machine in conjunction with the second data card interface device to read from said data card said treatment parameters; and

for each of said parameters:

displaying on a display device associated with the dialysis machine said parameter;

querying, via the display device, whether the displayed parameter is correct and soliciting operator verification of same; and

establishing the displayed parameter as a treatment parameter only if the operator verifies said parameter.

9. A kidney dialysis machine comprising:

a dialyzer with a dialysate compartment, a blood compartment separated from the dialysate compartment by a dialysis membrane, a dialysate input, a dialysate output, a blood input, and a blood output;

means for preparing dialysate and means for circulating the dialysate through a dialysate circuit, the dialysate circuit including the dialysate compartment, the dialysate input and the dialysate output of the dialyzer;

means for effecting extracorporeal circulation of blood from a dialysis patient through a blood circuit, the blood circuit including the blood compartment, the blood input, and the blood output of the dialyzer; and

means for effecting a preselected net passage of liquid from the blood compartment through the dialysis membrane to the dialysate compartment.

10. A kidney dialysis machine as recited in claim 9 further comprising:

a bypass valve in the dialysate circuit for automatically shunting dialysate flow away from the dialysate compartment; and

a flow sensor in the dialysate circuit for sensing that no dialysate is flowing to the dialysate compartment from the kidney dialysis machine whenever the bypass valve is shunting dialysate flow away from the dialysate compartment.

11. A kidney dialysis machine as recited in claim 9 further comprising:

a valve in the dialysate circuit adapted to automatically shunt dialysate away from the dialysate compartment; and

a flow sensor in the dialysate circuit for sensing that no net passage of liquid from the blood compartment to the dialysate compartment or from the dialysate compartment to the blood compartment occurs whenever said valve is shunting dialysate away from the dialysate compartment.

12. A kidney dialysis machine as recited in claim 9 wherein said means for effecting a preselected net passage of liquid from the blood compartment through the dialysis membrane to the dialysate compartment comprises means for delivering a first volume of dialysate to the dialysate compartment of the dialyzer, means for simultaneously removing a second volume of dialysate equal to the first volume from the dialysate compartment of the dialyzer, and an ultrafiltration flow meter situated in the dialysate circuit between said means for delivering the first volume and said means for delivering the second volume, the ultrafiltration flow meter operable to remove a preselected volume of liquid from the dialysate circuit between said means for delivering the first volume of dialysate and said means for removing a second volume of dialysate.

13. A kidney dialysis machine as recited in claim 12 including;

means for creating a volumetrically closed hydraulic loop in the dialysate circuit between said means for delivering the first volume and means for removing the second volume; and

pressure-monitoring means for monitoring hydraulic pressure in the closed loop against pressure alarm limits.

14. A kidney dialysis machine as recited in claim 13 operable to perform a self-test of said means for effecting a preselected net passage of liquid from the blood compartment through the dialysis membrane to the dialysate compartment, wherein the ultrafiltration flow meter removes a preset volume of liquid from the closed loop, and said pressure monitoring means monitors a corresponding drop in pressure in the closed loop for a preset amount of time against the pressure alarm limits.

15. A kidney dialysis machine as recited in claim 9 including means for individually preparing a first type of dialysate and means for individually preparing a second type of dialysate, wherein said means for preparing the first type of dialysate comprises a first concentrate pump, a first concentrate line coupled to the first concentrate pump and having a connector end, and a first rinse fitting adapted to receive the connector end of the first concentrate line; and

said means for preparing the second type of dialysate comprises both said means for preparing the first type of dialysate and a second concentrate pump, a second concentrate line coupled to the second concentrate pump and having a connector end, and a second rinse fitting adapted to receive the connector end of the second concentrate line.

16. A kidney dialysis machine as recited in claim 15 further comprising proportioning-mode control means interfaced with said means for preparing the first type of dialysate and said means for preparing the second type of dialysate, said proportioning-mode control means operable to engage said means for preparing the first type of dialysate whenever the connector end of the second concentrate line is coupled to the second rinse fitting and to engage said means for preparing the second type of dialysate whenever the connector of the second concentrate line is not coupled to the second rinse fitting.

17. A kidney dialysis machine as recited in claim 16 wherein said proportioning-mode control means further comprises a proximity sensor provided in each of the first and second rinse fittings for sensing whether or not the connector end of the first concentrate line is connected to the first rinse fitting and whether or not the connector end of the second concentrate line is connected to the second rinse fitting.

18. A kidney dialysis machine as recited in claim 9 further comprising control means operable to determine an expected conductivity reading of the dialysate prepared by said means for preparing dialysate and to automatically set conductivity alarm limits around said expected conductivity reading.

19. A kidney dialysis machine as recited in claim 12 wherein said means for delivering a first volume of dialysate to the dialysate compartment of the dialyzer and said means for simultaneously removing a second volume of dialysate equal to the first volume from the dialysate compartment of the dialyzer collectively comprise a flow equalizer comprising a first chamber and a second chamber substantially equal in volume to the first chamber, each chamber divided by a flexible impermeable membrane into a "pre-dialyzer" compartment and a "post-dialyzer" compartment, the "pre-dialyzer" compartment of the first chamber and the "post-dialyzer" compartment of the second chamber operable to alternately fill and empty simultaneously, and the "post-dialyzer" compartment of the first chamber and the "pre-dialyzer" compartment of the second chamber operable to alternately fill and empty simultaneously alternately with the "pre-dialyzer" compartment of the first chamber and the "post-dialyzer" compartment of the second chamber.

20. A kidney dialysis machine as recited in claim 19 wherein each "pre-dialyzer" compartment has an inlet and an outlet and each "post-dialyzer" compartment has an inlet and an outlet, the flow equalizer further comprising inlet valves each having an outlet coupled to the inlet of a corresponding "pre-dialyzer" and "post-dialyzer" compartment, and outlet valves each having an inlet coupled to the outlet of a corresponding "pre-dialyzer" and "post-dialyzer" compartment, where the inlets of the valves coupled to the inlets of the "pre-dialyzer" compartments are coupled together and the inlets of the valves coupled to the inlets of the "post-dialyzer" compartments are coupled together so as to form a flow-equalizer inlet, and where the outlets of the valves coupled to the outlets of the "pre-dialyzer" compartments are coupled together and the outlets of the valves coupled to the outlets of the "post-dialyzer" compartments are coupled together so as to form a flow-equalizer outlet.

21. A kidney dialysis machine as recited in claim 20 further comprising first pressure equalizing means coupled to the inlet of the flow equalizer for equilibrating hydraulic pressures at the inlets of the "pre-dialyzer" and "post-dialyzer" compartments and second pressure equalizing means coupled to the outlet of the flow equalizer for equilibrating hydraulic pressures at the outlets of the "pre-dialyzer" and "post-dialyzer" compartments.

22. A kidney dialysis machine as recited in claim 21 further comprising sensing means for automatically determining end-of-stroke times for the first and second chambers of the flow equalizer.

23. A kidney dialysis machine as recited in claim 9 further comprising means for automatically turning on preselected machine functions after a preselected duration of a power-off condition.

24. A kidney dialysis machine as recited in claim 9 further comprising means for automatically preserving machine operating parameters during a power-off condition, the machine operating parameters including a value representing a net volume of liquid passed from the blood compartment through the dialyzer membrane to the dialysate compartment.

25. A kidney dialysis machine as recited in claim 9 adapted to effect extracorporeal circulation of blood using a blood-line set having at least one drip chamber for containing a volume of blood up to a preselected level in the chamber, the machine further comprising a drip-chamber level adjuster including an automatically actuated valve having a first end coupled to the drip chamber and a second end coupled to a reversible positive-displacement pump, the pump and valve controllably actuatable to permit a machine operator to selectively raise and lower the level in the chamber.

26. A kidney dialysis machine as recited in claim 9 further comprising means for circulating the dialysate through the dialysate circuit at a preselected flow rate and means for circulating the dialysate through the dialysate compartment at a flow velocity in excess of a flow velocity corresponding to the preselected flow rate.

27. A kidney dialysis machine as recited in claim 9 further comprising:

means for circulating dialysate through the dialysate circuit at a preselected flow rate;

a blood-leak detector in the dialysate circuit located downstream of the dialysate compartment, the blood-leak detector including an LED for generating light for passing through the dialysate passing through the blood-leak detector, and a photodetector for receiving

light from the LED that has passed through the dialysate in the blood-leak detector, where the LED generates light at an intensity that is proportional to the flow rate of the dialysate.

28. A kidney dialysis machine as recited in claim 9 further comprising electronic memory operable to store information selected from a group consisting of machine calibration data, past machine calibration dates, future machine calibration dates, and machine calibration procedures, and to retrieve said information on demand by a machine operator.

29. A kidney dialysis machine as recited in claim 29 further comprising a microprocessor operable to control operation of activatable machine components, receive data from said machine components pertaining to operational status of said machine components, generate warning messages if the machine components operate outside preset operational limits, store said warning messages in the electronic memory, and recall and display said warning messages on demand by a machine operator.

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